Report on the metalworking remains at Killaclug 2, Co. Cork (E004944)

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Introduction

During excavations ahead of infrastructure works at Killaclug 2, Co. Cork, an extensive late medieval industrial complex was uncovered consisting of a limekiln and milling infrastructure. Next to this, the remains of an unusual iron smelting furnace dated to the late 7th to 8th century AD were found, as well as an associated hearth, likely related to bloom processing. Disturbed slag material suggests at least one more set of furnace – hearth were present.

Description of the material

The furnace remains consist of a pit (47) measuring 0.45m by 0.42m, with a depth of 0.21m and a steeply concave profile. Its basal fill 365 was mid-grey silty clay with charcoal inclusions but no slag. Above this was fill 364 consisting of brownish black sandy clay which was reddened lower down. This contained both rather dense slag showing flow structure and more friable, less dense material (Fig. 1). Radiocarbon analysis of a carbonised oak twig from this context returned a date late 7th to 8th centuries AD. Related to this is context 379 which consisted of paleochannels, either animal burrows or root systems, filled with slag stretching over an area measuring 1.16m by 0.86m and 0.28m deep. The slag formed both masses and tube-like structures (Fig. 2) up to 0.28m long with some of the masses being connected by thin slag tubes, testimony to the fluidity of the slag before cooling. Upper fill 293 yielded similar slag (Fig. 3) as 364 with a higher proportion of friable material together with strongly heat-affected clay. The largest piece of this clay material has a convex outer edge which was heavily vitrified (Figs. 4) and two of the smaller pieces show angled (90 degree) edges. These are most likely fragments of the vitrified side of a round-fronted ceramic tuyere.

One meter to the east, feature 100 was uncovered, a bowl-shaped hollow measuring 0.57m by 0.44m and a depth of 0.17m. Its single fill 292 was charcoal-rich silty clay and its base was heat-affected. The fill contained a single slag cake weighing just under 4.5kg with clay, some of heat-affected, and pebbles adhering to most of its base (Fig. 5). *Maloideae* charcoal from the fill of the hearth was radiocarbon dated to the late 7th to 8th centuries AD.

A similar slag cake (Fig. 6), weathered and weighing just under 2kg was recovered from fill 592 within wheel pit 108 of the late medieval mill. This cake has adhering heat-affected clay on its base and three sides. Basal fill 499 of that same wheel pit yielded a few grams of corroded iron flakes.

From the upper fill 90 of tail race 21 came weathered rather dense slag with hollows after timber fragments and flow structure (Fig. 7) and a piece of slag with pebble inclusions. Similar slag with flow structure and hollows after timber pieces was recovered from topsoil.

Further small amounts of slag were found in fill 664 of wheel pit 111 and, in the shape of rather light globules, within fill 563 of slab foundation 102.

Fill 366 within irregular linear feature 49, measuring 2.90m by 1.15m wide and a depth of 0.35m, yielded quantities of natural manganese oxide varying from flat deposits to tube-like structures (Fig. 8).

Discussion

Early iron smelting in Ireland was typically carried out in so-called slag pit furnaces (Rondelez 2018). These installations consisted of a clay shaft built over a pit which was filled with organic material, generally timber fragments. During smelting, the slag descends into the pit and solidifies around the timber fragments while the bloom forms just above ground level. The slag fragments with flow structure and impressions after timber found in the tail race and topsoil at Killaclug are good examples of this.

In furnace 47, however, most the slag did not settle in the pit but entered paleochannels at its side, leading to the complex of slag masses and tubes. The friable slag recovered from the two uppermost fills is recognizable as ‘furnace cake’ which occurs between the slag with flow structure and the bloom (Young 2003, Rondelez 2018).

The likely vitrified tuyere fragments from the upper fill of the furnace are unusual as these are characteristic for early iron smithing in Ireland, not smelting. In this setting, it is most likely related to bloom reheating after the smelt.

Heart 100 is an intriguing feature. The large slag cake it contains is of a type known from both Early and Late medieval contexts in Ireland but still poorly understood. It would appear that these large cakes, weighing between 1 and 5kg, are related to bloom processing and it has been suggested that they could represent 'slag baths': remolten slag which creates an environment which would have changed the properties of the bloom (Young 2009).

Remarkable in the slag cake from the hearth, and even more pronounced in the lighter cake from wheel pit 108, is the occurrence of clay not only on the base of the cake but also on multiple sides. The post-ex picture of hearth 100 (Fig. 9), with the slag cake in situ, shows that the cake would have touch one side of the hearth at most. This would appear to suggest a clay layer between the slag and the charcoal used for heating the slag, re-enforcing the idea that this is, indeed, a slag bath as opposed to slag formed as a result of the activity taking place.

The flakes of iron in the basal fill of that same wheel pit are possibly fragments of the iron or steel rynd, spindle or other parts of the mill wheel.

The globular slag, likely the waste from iron smithing, recovered from the slab foundation of one of the wheel pits might represent the waste from iron working related to the construction of the mill.

The manganese oxide formations would have formed in the same way as bog iron ores but it is unclear how the tube-like structures developed, possibly also in paleochannels like the slag. The linear feature wherein it was found was possibly the result of the extraction of the manganese ore. Manganese-rich ores were widely sought after in the past and are known to lead to superior types of iron and steel (see, for example, Iles 2014). While some Irish bog iron ores are naturally high in manganese, oxides of the same could have been added to obtain the same results.

Conclusions

The site at Killaclug 2 revealed the remains of a late 7th to 8th centuries AD iron smelting furnace. It is of the slag-pit variety, the type most commonly used in that period, but instead of solidifying within the pit under the furnace, much of the slag entered paleochannels at its side.

A hearth associated with furnace 47 was most likely used in some manner of bloom processing and it is suggested, based on the clay adhering to most of the base of the slag cake, that this can be interpreted as a 'slag bath'. The precise effect of submerging bloom material in re-liquified slag remains unknown.

Redeposited smelting slag, of the more classical slag-pit type, and a further slag cake with extensive adhering clay to its base, suggests there was originally at least one more furnace-hearth set present on the site which was subsequently removed by the building of the mills.

Smaller amounts of slag and iron were possibly related to the construction and working of the mills.

An elongated hollow yielding natural manganese oxide formations might be an extraction pit for that material.

Bibliography

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Catalogue

Cut	Fill	Feature	Description	Weight g
-	50	Topsoil	Fragment of rather dense slag with clear flow structure. Impressions of timber or charcoal fragments	301
-	58	Deposit	Fragment of weathered rather dense slag with flow structure	16
8	73	slot	Small piece of rather dense drippy slag (flow structure)	23
21	90	Mill race	Weathered mass of rather dense slag with flow structure and hollows after timber fragment (furnace pit slag)	765
21	90	Mill race	Piece of slag with multiple inclusions of pebbles	84
47	293	Furnace pit	Irregular shaped piece of friable slag with some flow structure	332
47	293	Furnace pit	Bag of smaller fragments of slag mostly consisting of friable slag but with some denser pieces with flow structure	657
47	293	Furnace pit	Six fragments of heat-affected clay with strong vitrification. The clay consists of fine grained clay with very occasional inclusions of small angular stones. The largest piece shows the outer vitrified surface to be convex. Two of the smaller pieces have angled/90 degree edges. Likely tuyere material	176
47	364	Furnace pit	Bag of smaller fragments of slag mostly consisting of friable slag but with some denser pieces with flow structure	1964
47	379	Paleo-channels	Over 100 pieces of rather dense slag which has solidified in paleo-channels under the furnace. Varying from rather large masses to thin tube-like structures. The masses are connected to others by thin tubes	4918
49	366	Linear	Three pieces of manganese oxide, two of which consist of a long tube-like structure	
100	292	Hearth	Large concave rather dense slag cake with a rounded bottom to which partially heat-affected clay and pebbles are attached. The upper surface is flat with two pronounced depressions at one side and an upstanding rim at the other.	4494
100	292	Hearth	Multiple fragments of rather light friable	657
100	292	Hearth	Bag of multiple small slag fragments. Most are magnetic	63
102	563	Slab foundation	Two small globular nodules of rather light slag	10
108	499	Wheel pit	Flakes of corroded iron	3
108	592	Wheel pit	Large concave slag cake with flattish upper surface with a small protrusion. Heat-affected clay adhering to base and three sides. The clay is reduced in most places but oxidized where it was closest to the surface. Upper surface has impressions after charcoal. Slag bath?	1906
111	664	Wheel pit	Weathered drippy slag fragment	7

Figures *(scale 10cm unless stated otherwise)*

Fig. 1. Friable 'furnace cake' fragments from mid fill 364 in furnace 47

Fig. 2. Slag masses and tubes from paleochannels 379 (scale 20cm)

Fig. 3. Slag with flow structure from upper fill 293 in furnace 47

Fig. 4. Likely tuyere fragment from upper fill 293 in furnace 47

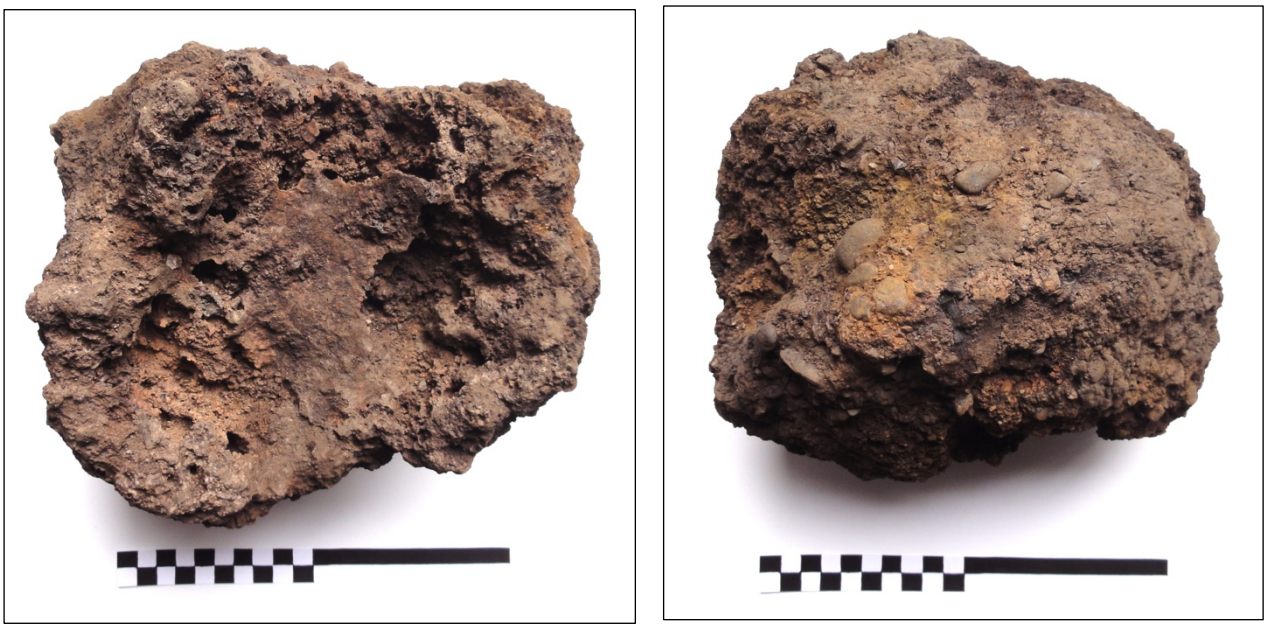

Fig. 5. Slag cake from fill 292 in hearth 100 (upper and lower side, scale 20cm)

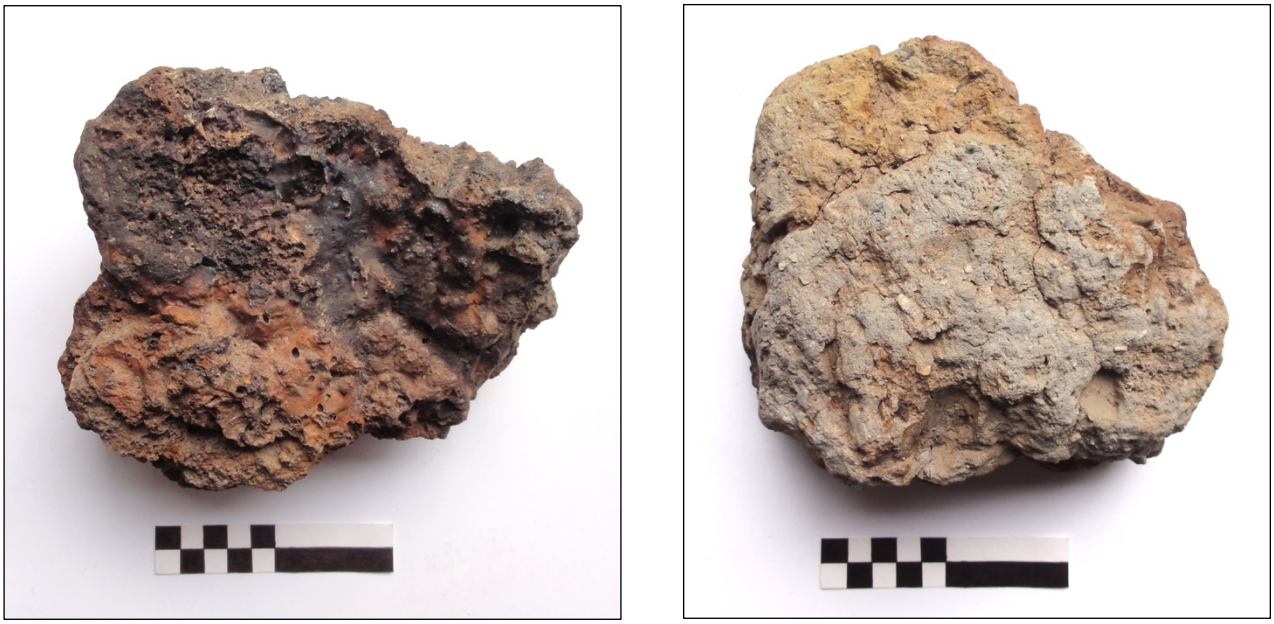

Fig. 6. Slag cake from fill 592 in wheel pit 108 (upper and lower side)

Fig. 7. Slag with flow structure and hollows after timber fragments from fill 90 in mill race 21

Fig. 8. Tube-like formations of manganese oxide from fill 366 in linear feature 49

Fig. 9. Post-ex of hearth 100 with 'slag bath' in situ